Particulate Matter Concentration–Response Versus Dose–Response

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Epidemiological assessments of health outcomes are frequently restricted to available data on ambient pollutant concentrations. This constraint, however, does not require that toxicological studies similarly limit their assessments. Since total exposure (the product of concentration, ventilation, and exposure duration) of a gaseous pollutant, such as ozone, is proportional to target tissue dose, total exposure is a better predictor of acute responses than concentration. For particulate matter (PM), however, neither concentration nor total exposure should be presumed proportional to dose. We reviewed studies reporting inflammatory responses to concentrated ambient particles (CAPs). The constituents, sources, and the toxicity of CAPs are thought to vary regionally and seasonally. Where sufficient information was available, we estimated the dose of CAPs to regions of the lung using a mathematical model. No consistent relationship between predicted respiratory dose of PM and pulmonary inflammation was observed; however, CAPs size distribution data was absent or incomplete in the majority of studies. Particle size alone is recognized to affect the location and amount of deposition in the lungs as well as subsequent clearance rates. For example, the dose of 0.1-μm particles in the pulmonary region of a resting rat is predicted to be about threefold greater than for 1.0-μm particles at equal exposure concentrations. Consequently, the 0.1-μm particles might appear more toxic by virtue of their higher pulmonary dose. The lack of such basic information as the size distribution of CAPs prevents accurate dose estimates and adds to the uncertainty in cross-study comparisons. Accurate reporting of PM concentration and size distributions to yield improved dose estimates in toxicology studies may reduce uncertainty and improve assessment of regional and seasonal PM health effects.

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